Panagiotis Apostoli – Irene Christofi

GENERAL METHODOLOGY FOR THE SOLUTION OF DIFFERENTIAL EQUATIONS: APPLICATION TO THE TRANSVERSE DEFLECTION OF AN EULER BEAM

The main objective of this undergraduate thesis was the familiarization with the various techniques pertaining to the solution of ordinary and partial differential equations on the basis of mainly finite element and finite difference methodologies. To this end, we studied the development of the mathematical model characterizing the physical problem, investigated the techniques associated with non-dimensionalization of this model and the extraction of the appropriate non-dimensional groupings as well as the temporal and spatial scales thereof and finally formulated the numerical analogues (finite element, finite difference and asymptotic) used in the determination of the solutions.

As an application of the finite element method we considered the solution of the transverse displacement of an Euler beam. More specifically, we designed and implemented a numerical code in MATLAB™ which can be used to calculate the deflection and slope along the span of a prismatic beam under the influence of arbitrary loads (point forces, point moments and distributed loads) and general boundary conditions (simple supports, built-in supports and free ends) which are input by the user. The program is structured according to standard commercial prototypes; namely, it consists of a pre-processor, a processor and a post-processor. The accuracy of our program was verified via corresponding results from the commercial Finite Element software package ADINA™ and, where possible, from analytical results found in bibliographical references.

Based on the findings of this degree thesis, it can be concluded that the orthological solution of any system of differential equations must adhere to the following procedure. Firstly, the mathematical model must be developed, or, if it exists, it must be verified for accuracy. Subsequently, the aforementioned model must be non-dimensionalized and then the optimum solution technique (finite element, finite difference, asymptotic etc.) must be selected. Finally, the non-dimensional model is solved on the basis of the selected technique and then transformed back to its dimensional counterpart.